

# **Sacramento Valley Water Management Agreement Technical Measurement and Monitoring Committee**

## **Technical Memorandum #2 2003 Technical Measurement and Monitoring Committee Summary Report**

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### **Introduction**

This report summarizes the activities of the Technical Measurement and Monitoring Committee (TMMC), as specified in Task 7 of Exhibit A, Attachment 3 to the Sacramento Valley Water Management Agreement (SVWMA) Program Scope of Work. As specified in Task 7, the TMMC Annual report will:

- Evaluate the performance of any short-term projects undertaken in 2003
- Summarize the results of initial measurement and monitoring activities during 2003
- Document the measurement and monitoring activities undertaken by short-term projects in 2003

As described in the body of this report, due to hydrological and operational circumstances occurring in 2003, no short-term projects proceeded in 2003 (although water supply commitments were proposed by Upstream Users as part of a draft Annual Operating Plan). Consequently, most of the specific deliverables identified in the SVWMA Scope of Work are not applicable. The remainder of this report describes the events that occurred during 2003, the issues considered by the TMMC, and the results of TMMC efforts.

### **SVWMA Background**

Based on discussions in 2002, the SVWMA was expected to be in operation by the beginning of 2003, if not earlier. However, actual execution of the SVWMA did not occur until early 2003, which did not provide sufficient time to complete the necessary environmental documentation prior to project implementation. This resulted in a change in focus for the first year activities of the TMMC from that in the scope of work under the Northern California Water Agency contract with DWR.

Early in 2003, water supply conditions were dry and reservoir storage levels were low, creating interest among water users in implementing short-term projects that could supply 50,000 acre-feet of water. Sacramento Valley participants to the SVWMA began efforts to identify potential short-term programs through the

development of a draft Annual Operating Plan. At the same time, potential California Environmental Quality Act (CEQA) compliance approaches were identified. Due to the compressed time frame for implementation in 2003, development of the Short-Term Projects and completion of environmental documentation were determined to be challenging. Consequently, the Management Team determined that the program should not be implemented in 2003, but rather the initiation date be moved out two years to allow for adequate environmental review.

### **TMMC Activities during 2003**

The initial meeting of the TMMC on March 7 included a review of its responsibilities under the SVWMA along with discussions of the required 2003 Annual Operations Plan, definition of the operational baseline, and identification of the short-term projects. The TMMC was aware that there was some question at that time about whether the short-term projects would proceed, but needed to be ready to support their implementation. A Groundwater Subcommittee was thus identified by the TMMC to take the lead with respect to development of a groundwater monitoring plan, prediction of project impacts and support for environmental documentation efforts. Members of the TMMC and the Groundwater Subcommittee are reported in Attachment 1.

At their March 31 meeting, the TMMC reviewed additional detail on potential short-term projects for Glenn-Colusa Irrigation District, Maxwell Irrigation District and Yuba County Water Agency. Operational issues and potential monitoring requirements were discussed for each possible project, along with a review of the likely permitting approach.

The initial Groundwater Subcommittee meeting was held on April 1. At this meeting, the responsibilities of the Subcommittee were reviewed and the detailed monitoring needs for the identified Short-Term Projects were discussed.

During April, water supply conditions improved dramatically and export water users indicated that they would not request the water potentially available through the Short-Term Water Supply Projects. Without an imminent need for evaluation of 2003 projects, the TMMC did not have any more meetings during 2003.

### **Groundwater Subcommittee Activities**

The Groundwater Subcommittee of the TMMC did continue to have meetings; however, its activities shifted from monitoring program development to providing an evaluation of potential water level and related impacts for the SVWMA Short-Term Programmatic Environmental Impact Study/Report (EIS/EIR).

The focus of the Subcommittee's activity was developing an evaluation approach that could be used to evaluate stream and aquifer interaction, to assist in

quantifying available water and predict water level impacts for the purposes of subsequently developing a monitoring plan.

Superposition modeling was selected as the analytical methodology, with supplemental use of existing calibrated groundwater models where available and as applicable (as in the Stony Creek Fan and Yuba County). Superposition modeling allows detailed specification of program geometry and stratigraphy, without requiring identification of all background groundwater pumping, recharge and discharge. An advantage of the superposition modeling is that its output can be interpreted to identify potential impacts which, in turn, can serve as a basis for developing a monitoring program for ultimate measurement of actual impacts (and comparison to predicted impacts as appropriate). Superposition modeling provides information on potential groundwater level and direct stream-aquifer impacts that will be utilized in the environmental documentation. A description of the Superposition Modeling approach used by the Groundwater Subcommittee in contained in Attachment 2. This quantitative approach was not originally envisioned as part of the assessment process, but was selected by the Subcommittee to be a necessary and useful step to assessing stream/aquifer interaction and potential local and regional impacts, and to provide a basis for the development of a monitoring approach and plan. A presentation summarizing the overall proposed evaluation (including modeling) approach was made to the Management Team on September 15, 2003 (Attachment 3).

In addition to development of the Superposition Modeling analysis, the Groundwater Subcommittee also began development of a quasi-quantitative analysis of aquifer recharge, after pumping cycles, based on historical groundwater basin conditions following selected short-term localized pumping activities. The Subcommittee also reviewed prior monitoring programs in the Sacramento Valley, discussed potential monitoring needs and reviewed other available groundwater modeling activities in the Sacramento Valley. Updated descriptions of likely Short-Term Water Projects were reviewed in detail.

## **Next Steps**

As described above, the TMMC's activities were considerably different than anticipated, primarily due to the deferral of Short-Term Water Supply Projects. A proposed revised scope of work for the TMMC is being prepared to reflect the change in project implementation schedule and the increased emphasis on support of the ongoing environmental analyses. The revised scope of work will be submitted to the Management Committee for consideration in 2004. In addition, during 2004, the TMMC activities will include the following:

- In cooperation with DWR and USBR design and, to the extent practicable, implement a monitoring program to provide information on pre-project conditions.

- Propose monitoring well specifications and measurement and monitoring protocols for groundwater levels and other selected parameters, e.g. groundwater quality, stream stage and/or flow, surface water quality, land subsidence, etc.
- Summarize the results of initial measurement and monitoring activities during 2004.
- Coordinate with local project sponsors to design and, to the extent practicable, implement project-specific monitoring programs for projects expected to be implemented in 2005.
- Complete input to the development of the EIS/EIR.

ATTACHMENT 1

# Technical Measurement/Monitoring and Groundwater Subcommittee List of Members

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## Technical Measurement/Monitoring Committee Members

Marc Van Camp/MBK Engineers  
Terry Erlewine/State Water Contractors  
Laura King Moon/State Water Contractors  
Jim Snow/WWD  
Tom Bettner/WWD  
Tom Boardman/MWD  
Mary Wells/TCCA  
Tom Barandes/NCMWC  
Tracy Slavin/USBR  
Jerry Johns/DWR  
John Fielden/DWR  
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J. Leahigh/DWR  
Dave Schuster/SWRI  
Steve Grinnell/MWH  
Roger Putty/MWH  
Gary Nuss/CH2M HILL  
Mark Oliver/CH2M HILL

## Groundwater Subcommittee Members

Joe Scalmanini/Luhdorff & Scalmanini  
Terry Erlewine/State Water Contractors  
John Fielden/DWR  
Toccoy Dudley/DWR  
George Matanga/USBR  
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William Shipp/USBR  
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Roger Putty/MWH  
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# Groundwater Model Documentation

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## 1.0 Model Objectives

The Sacramento Valley Water Management Program (SVWMP) is a collaborative program involving numerous State and Federal Agencies and water districts. The SVWMP is seeking to improve the reliability of water supply throughout the Sacramento Valley by implementing conjunctive water management (CWM) projects. Two oversight committees were developed to provide guidance in evaluating the potential benefits and impacts of implementing such projects: the Technical Measurement and Monitoring Committee, and the Groundwater Subcommittee. These two committees include agency, water district, and consultant experts (see Attachment 1 for a list of members).

The two most critical potential impacts from additional groundwater pumping are depression of local groundwater levels and changing the hydraulic relationship between the surface water and groundwater systems in the area. Two primary impacts can potentially occur to surface streams. The first is interception and resultant reduction of groundwater discharge to surface streams. The second is reversing the direction of the hydraulic gradient between the aquifer and the surface stream, resulting in direct leakage from the stream to the underlying aquifer. The timing of these impacts is critical, especially in the case of potential surface water impacts, because acceptable impacts to surface water flows at one time of year may be unacceptable during others. Given the absence of an accepted holistic analytical approach, a numerical groundwater modeling tool was developed to evaluate the impacts of CWM projects proposed in the SVWMP on groundwater levels and stream flows near the proposed project sites. Specific objectives of the modeling effort include:

- Development of a regional-scale superposition model covering the Sacramento Valley groundwater basin
- Quantification of both cumulative and project-specific impacts to streams resulting from the implementation of actions proposed in the SVWMP
- Calculation of program-wide and project-specific drawdown in groundwater levels resulting from the implementation of CWM projects

The final component of the groundwater system that will be analyzed is the recharge characteristics of the groundwater basin over the winter months. Historical data suggest that during past groundwater substitution projects, water levels that were depressed due to project pumping fully recovered by the start of the following irrigation season. A combination of historical water level data and model simulations will be used to estimate the basin response to pumping from year to year.

## 2.0 Geologic Setting

The Sacramento Groundwater Basin is a north-northwestern trending asymmetrical trough filled with as much as 10 miles of both marine and continental rocks and sediment (Page, 1986). On the eastern side, the basin overlies basement bedrock that rises relatively gently to form the Sierra Nevada; on the western side, the underlying basement bedrock rises more steeply to form the Coast Ranges. Overlying the basement bedrock are marine sandstone, shale, and conglomerate rocks, which generally contain brackish or saline water. The more recent continental deposits overlying the marine sediments contain fresh water. These continental deposits are generally 2,000 to 3,000 feet (ft) thick (Page, 1986). The depth to the base of fresh water typically ranges from 1,000 to 3,000 ft below ground surface (bgs) (Bertoldi et al., 1991).

In the Sacramento Valley Groundwater Basin, groundwater users pump primarily from deeper continental deposits. Groundwater is recharged by deep percolation of applied water, rainfall infiltration from streambeds, and lateral inflow along the basin boundaries. The quantity and timing of snowpack melt are the predominant factors affecting the surface water and groundwater hydrology, and peak runoff in the basin typically lags peak precipitation by 1 to 2 months (Bertoldi et al., 1991). The main surface-water feature in the Sacramento Groundwater Basin is the Sacramento River, which has several major tributaries draining the Sierra Nevada, including the Feather River, Yuba River, and American River. Stony Creek, Cache Creek, and Putah Creek, draining the Coast Range, are the main west-side tributaries of the Sacramento River.

## 3.0 Model Design

### 3.1 Model Code Description

MicroFEM (Hemker, 1997), an integrated groundwater modeling package developed in the Netherlands, was chosen by the Groundwater Subcommittee to simulate the groundwater flow system in the Sacramento Valley. The current version of the program (3.60.15) has the ability to simulate up to 25 layers and 250,000 surface nodes. MicroFEM is capable of modeling saturated, single-density groundwater flow in layered systems. Horizontal flow is assumed in each layer, as is vertical flow between adjacent layers. A layered aquifer system or different aquifers within a multiple-aquifer system can be modeled in this manner.

In addition to there currently being no universally accepted tool or approach to evaluating benefits and impacts, the MicroFEM model was selected for the following reasons:

- The finite-element scheme allowed the construction of a model grid covering over 5,955 square miles (9,589 square kilometers [km<sup>2</sup>]) with a coarse node spacing outside of the simulated project areas and a finer node spacing within areas of high project density. The finer node spacing near simulated extraction wells provides greater resolution of simulated groundwater levels and stream impacts.

- The graphical interface allows rapid assignment of aquifer parameters and allows proofing of these values by graphical means.

## 3.2 Model Construction

### 3.2.1 Model Grid

The Sacramento Valley CWM projects were evaluated using a six-layer, transient superposition model. The premise of this type of model is that all existing groundwater sources and sinks represent baseline conditions and are not explicitly simulated in the model. The impacts identified by this modeling effort will be only those created by project operations and will not reflect forecasts of the total groundwater or stream impacts that will be experienced in the Sacramento Valley.

The Sacramento Valley model grid consists of 152,261 nodes and 304,011 elements. Nodal spacing varies from 6,562 ft (2,000 meters [m]) near the model boundary and in areas with no or few CWM projects to 410 ft (125 m) in areas with a high density of projects (Figure 1). Thirteen zones of refined nodal spacing are located throughout the model domain, where projects or groups of projects in close proximity are located. The finer spacing in the area of interest allows for a more refined estimate of the groundwater levels and groundwater/surface water interaction in the project areas. The model boundary represents the extent of the fresh water aquifer in the Sacramento Valley.

The total model thickness represents the thickness of the fresh water aquifer (approximately 3,000 micromhos/cm) as defined by Berkstresser (1973). Contour lines of the base of fresh water, along with measurements from borings were digitized and used to generate an x,y,z file containing the elevation of the base of fresh groundwater at regularly spaced intervals. The elevation (z) of the base of fresh groundwater was then subtracted from the land surface elevation at all x,y locations to produce a total aquifer thickness distribution. This total thickness was assigned to every node in the model and subsequently divided into six layers. The default layering system was designed such that the first five layers have a total thickness of 750 ft (Layer 1 = 0 to 50 ft bgs, Layer 2 = 50 to 150 ft bgs, Layer 3 = 150 to 250 ft bgs, Layer 4 = 250 to 350 ft bgs, Layer 5 = 350 to 750 ft bgs). Any thickness in excess of 750 ft was apportioned to Layer 6 (750 ft bgs to the base of fresh groundwater). The assumed thicknesses for Layers 1 through 5 are based on typical screened intervals of wells in the Sacramento Valley. In areas where the total aquifer thickness was less than 750 ft, Layer 6 was assigned a thickness of 3.281 ft (1 m) and Layers 1 through 5 were assigned a value based on the ratio of layer thickness to a total thickness of 750 ft in the default layering scenario (Layer 1 = 50 ft/750 ft or 6.67 percent; Layers 2, 3, and 4 = 100 ft/750 ft or 13.3 percent; and Layer 5 = 400 ft/750 ft or 53.3 percent). For example, if the total thickness at a model node were 400 ft, individual layer thickness would be approximately 27 ft (Layer 1), 53 ft (Layers 2, 3, and 4), 211 ft (Layer 5), and 3 ft (Layer 6). This approach enabled relative ratio of layer thickness to be maintained as the total thickness decreased toward the model boundary.

### 3.2.2 Boundary Conditions

Boundary conditions are mathematical statements describing either the head or the flux at specific locations within the model domain (Anderson & Woessner, 1992). Boundary conditions can represent either physical boundaries, such as impermeable rock, or hydraulic

1 **Figure**  
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boundaries, such as groundwater divides or streamlines. The three types of boundary conditions include: specified head boundaries, where a constant head is defined along the boundary; specified flow boundaries, where a constant flux is defined along the boundary; and head-dependent flow boundaries, where the flux across the boundary is calculated as a function of a calculated head gradient and a conductance term, which regulates seepage.

A head-dependent boundary condition was chosen to simulate streams within the Sacramento Valley. The MicroFEM river system was used to implement streams within the model domain. MicroFEM's river package calculates the magnitude and direction of nodal fluxes based on the relative values of stream stage (rh1) and the head in the aquifer (h1) as follows:

Stream discharge to the aquifer will occur if  $h1 < rh1$ :

$$Q_{inflow} = a * (rh1 - h1) / |ri1|, \text{ where } a = \text{nodal area} \quad (1)$$

Stream recharge will occur if  $h1 > rh1$ :

$$Q_{outflow} = a * (h1 - rh1) / |rc1| \quad (2)$$

Nodal area is a grid-dependent parameter that can be automatically calculated within MicroFEM. In general, the nodal area is greater than the river surface area. The effective resistance terms (rc1 and ri1) incorporate an areal correction to account for this discrepancy. Additionally, river resistance terms account for the relationship between the streambed sediments and aquifer properties in the upper half of Layer 1 when calculating stream seepage. River resistances are calculated, using the following equation:

$$rc1 \text{ or } ri1 = ((Dr/Kr) + ((0.5 * mt1)/Kv1)) * (a/LW) \quad (3)$$

where:

- Dr = thickness of streambed sediments
- Kr = vertical hydraulic conductivity of streambed sediments
- mt1 = thickness of Layer 1
- Kv1 = vertical hydraulic conductivity of Layer 1
- A = nodal area
- L = stream length within the model node
- W = width of the wetted river channel in nodal area

Streams included in the model were selected according to size and location with respect to Phase 8 CWM projects (Figure 2). Table 1 contains a list of streams simulated in the model. Stream locations were digitized from existing basemaps and imported into the model grid. Stream length within a given node is a grid-dependent variable calculated by MicroFEM at each river node. The stream length term is generally overestimated by MicroFEM at stream confluences. Manual corrections of this term were made where necessary. Streambed thickness was assumed to be 3.281 ft (1 m) for all river nodes. The remaining components of the effective resistance parameter vary by stream; values for each are listed in Table 1.

2 **Figure**  
**Title**

Assumptions of vertical hydraulic conductivity (Kv) of streambed sediments were based on the type of streambed deposits expected for a given stream size. Wetted stream width was calculated from aerial photographs along each stream.

A no-flow boundary was used along the margins of the model domain to simulate the lateral extent of sediments in fresh water in the Sacramento Valley.

**TABLE 1**  
Components of River Resistance Term  
*Groundwater Model Documentation*

<b>Stream Name</b>	<b>Streambed Kv (ft/day)</b>	<b>Minimum Wetted Stream Width (ft)</b>	<b>Maximum Wetted Stream Width (ft)</b>
American River	1.00	181.39	461.60
Angel Slough	0.10	20.67	20.67
Antelope Creek	0.10	21.96	21.96
Bear River	0.10	80.41	100.76
Big Chico Creek	0.10	46.29	74.49
Butte Creek	0.10	63.94	98.07
Cache Creek	0.10	31.22	120.78
Colusa Basin Drain	0.03	32.83	124.98
Consumnes River	0.10	42.31	42.31
Deer Creek - Sac. Co.	0.10	39.72	39.72
Deer Creek - Tehama Co.	0.10	39.72	43.60
Dry Creek - Yolo Co.	0.10	29.82	29.82
Dry Creek - Yuba Co.	0.10	14.75	38.11
Elder Creek	0.10	40.05	83.32
Feather River	1.00	115.83	670.98
French Creek	0.10	19.38	21.96
Funks Creek	0.10	26.59	51.13
GCID Canal	0.03	46.29	100.44
Little Chico Creek	0.10	20.67	20.67
Mill Creek - Tehama Co.	0.10	30.14	56.73
Mill Creek - Thomes Branch	0.10	26.58	26.58
Mokelumne River	1.00	71.48	685.62
North Fork Walker Creek	0.10	19.38	19.38
North Mokelumne River	1.00	126.60	467.20
Paynes Creek	0.10	11.52	31.22
Putah Creek	0.10	24.33	73.52
Sacramento River	1.00	283.44	2684.78
Salt Creek	0.10	10.55	67.28
San Joaquin River	1.00	2689.09	2689.09
Sand Creek	0.10	8.50	21.64
Sevenmile Creek	0.10	25.30	25.30
South Fork Walker Creek	0.10	26.59	35.42
South Fork Willow Creek	0.10	11.52	29.17
Stone Corral Creek	0.10	38.11	51.13
Stony Creek	1.00	86.33	207.66

**TABLE 1**  
Components of River Resistance Term  
*Groundwater Model Documentation*

Stream Name	Streambed Kv (ft/day)	Minimum Wetted Stream Width (ft)	Maximum Wetted Stream Width (ft)
Thomes Creek	1.00	26.59	228.32
Walker Creek	0.10	17.44	46.94
Willow Creek	0.10	20.67	30.46
Wilson Creek	0.10	18.41	35.42
Yuba River	1.00	144.04	148.66

### 3.2.3 Aquifer Properties

A limited amount of quantitative information is available regarding aquifer properties in the Sacramento Valley. The sources of information used to develop the initial groundwater flow model are reports prepared by the California Department of Water Resources (the Department) and the U.S. Geological Survey. The distribution of aquifer transmissivity used in the Sacramento Valley model was derived from that reported by Bloyd (1978). Polygons, representing the reported transmissivity distribution, were first digitized into an electronic format, then sampled at 164 ft (50 m) centers to produce an x,y,z file containing aquifer transmissivity at 50-m intervals. It was assumed that the published transmissivity reflects the upper 750 ft of saturated sediments; therefore, the reported transmissivity was divided by 750 ft to obtain the horizontal hydraulic conductivity at every model node. The hydraulic conductivity was then multiplied by the thickness of each layer, resulting in a corrected transmissivity value at each model node. In areas with less than 750 ft of fresh water thickness, the reported transmissivity value was assumed to represent the total transmissivity for the available thickness of the fresh water aquifer at that location. The transmissivity for each layer was then assigned based on the percentage of total aquifer thickness represented by that layer.

There were regions where the study area of Bloyd (1978) did not cover an area equal to or greater than the Sacramento Valley model; therefore, no published transmissivity data was available at these locations. In these instances, transmissivity was calculated and assigned by using the hydraulic conductivity value of the nearest model node for which there was data available. A map of the total transmissivity for all model layers can be found in Figure 3.

The method for assigning transmissivity values described above was also used to assign specific yield values to Layer 1, using specific yield values reported by Bloyd (1978). A uniform specific storage of  $2 \times 10^{-6}$  per foot of aquifer thickness was assumed for Layers 2 through 6. An initial ratio of 100:1 between horizontal and vertical hydraulic conductivity was assumed throughout the model domain.

### 3.2.4 Distribution of Groundwater Pumping

Twenty-one proposed CWM projects were simulated with the Sacramento Valley model (Figure 2). Prior to and during model construction, information was gathered regarding the groundwater component of each project (number, location, target pumping rates, and construction details of existing and proposed extraction wells), the maximum annual project

3 **Figure**  
**Title**

supply, and the operation schedule for all projects. Data sources included the Department, individual water districts and their consultants, grant proposals, and the SVWMA Short-Term Workplan. Despite efforts to obtain the most current and accurate information, extensive data was not available for all projects. In such cases, baseline assumptions regarding the project were prepared. A summary of each project is located in Table 2.

Reported operation schedules ranged from two to six months in length, spanning a variety of schedules between April and October. In order to incorporate all 21 CWM projects into the model, it was assumed that all projects would operate 24 hours per day for a 153 day period (June – October). Other simplifying assumptions regarding the distribution of groundwater pumping include:

- Where screen interval information was available, pumping was proportioned vertically to match the relative screen length in each model layer.
- Where screen interval information was not available, pumping was assigned to the model layers representing depths from which typical agricultural wells in the project area produce.
- If target pumping rates were specified by the water districts or other sources, those rates were used in the model. In some cases, it was necessary to modify the reported pumping rate due to differences between the supplied operation schedule and the model's assumed operation period of 153 days.
- If target pumping rates were not available, the rate necessary to achieve the annual project supply was assigned equally to all extraction wells.
- In some instances, the reported pumping rates were either not sufficient to meet the annual project supply or the estimated pumping rates would be unrealistically high given the reported number of extraction wells. In these cases, additional well locations were incorporated into the model such that realistic pumping rates were assumed for the 153 day operation period.

Table 2 outlines the differences between reported project design and how each project was simulated in the model. Figure 2 shows the locations of extraction wells incorporated in the model.

## 4.0 Model Simulations

The model calculation consists of three stress periods. The first represents the 153 day period from June through October. During this period, all CWM projects are actively extracting groundwater. The model next simulates a post-pumping recovery period of approximately 61 days. This period represents the time in November and December when agricultural pumping has stopped and substantial groundwater recharge resulting from the rainy season has not yet begun. The final period represents the remainder of the year from January through the end of May. During this period there is continued recovery of groundwater levels and recharge from precipitation. Drawdown and stream leakage rates are calculated at the end of each stress period. Multiple model simulations were run in this

TABLE 2

Summary of Supplied Project Information vs. Model Implementation  
*Groundwater Model Documentation*

Project Index	Proponent	Groundwater Component Description	Maximum Project Supply (ac-ft)	Target Pumping Rate (gpm)	Screened Interval (ft bgs)	Number of Wells Simulated	Simulated Pumping Rate (gpm)
<b>Redding Sub-basin</b>							
2B	ACID	Installation of 12 production wells	20,000	2,000 to 3,500	200 to 500	12	2,450
<b>Feather/Butte Sub-basin</b>							
32A	RD 1004	Install one well	1,000	4,000	350-450 <sup>a</sup>	1	1,500
36A	Butte Water District	Installation of two groundwater extraction wells.	7,400	4,000	150 to 660 (two screen intervals per well)	3	3,650
37A	Feather Water District	Installation of one extraction well <sup>a</sup>	1,000 <sup>a</sup>	1,500 <sup>a</sup>	350-450 <sup>a</sup>	1	1,500
39A	Garden Highway Mutual Water Company	Installation of one extraction well <sup>a</sup>	1,000 <sup>a</sup>	1,500 <sup>a</sup>	350-450 <sup>a</sup>	1	1,500
12C	Sutter Extension Water District	Installation of two groundwater extraction wells. Nine MWs, three sites nested	7,400	4,000	150-390 and 520-680 (two screen intervals per well)	3	3,650
40A	Lewis Ranch	Installation of up to four groundwater extraction wells.	2,000	1,000 to 2,000	350 to 450	4	750
<b>Colusa Sub-basin</b>							
5B	Glen Colusa Irrigation District	Full utilization of private landowner wells used in the 2001 Forbearance Agreement (up to 71 wells). 20 MWs.	30,000	1,000 to 5,000	20 to 685	71	31 to 1,488
6A	Maxwell Irrigation District	Installation of up to three production wells	13,000	5,000 to 5,600	600 to 800	5	3,600-5,000
10A	RD 108	Development of five production wells and analysis of basin response	20,000	2,000 to 3,500	600 to 700	9	3,300

TABLE 2

Summary of Supplied Project Information vs. Model Implementation  
*Groundwater Model Documentation*

Project Index	Proponent	Groundwater Component Description	Maximum Project Supply (ac-ft)	Target Pumping Rate (gpm)	Screened Interval (ft bgs)	Number of Wells Simulated	Simulated Pumping Rate (gpm)
26A	Princeton-Codora-Glenn Irrigation District (PCGID)	Construct three groundwater extraction wells	5,000	2,500	150-250 <sup>a</sup>	3	2,500
27A	Provident Irrigation District (PID)	Construct three groundwater extraction wells	5,000	2,500	150-250 <sup>a</sup>	3	2,500
33A	River Garden Farms	Construct three groundwater extraction wells (one already installed, other two awaiting funding)	5,000	1,500 (existing well); 2,500 to 3,000 (2 additional wells)	365 to 570	3	1,500-3,000
34A	Deer Creek ID	Installation of one extraction well <sup>a</sup>	1,000 <sup>a</sup>	1,500 <sup>a</sup>	150-250 <sup>a</sup>	1	1,500
<b>Yuba Sub-basin</b>							
14AB	Yuba County Water Agency (YCWA)	Use of 189 existing wells.	15,000	1,000 to 4,000	119.25 <sup>a</sup>	189	119.25
38A	Plumas Mutual Water Company	Installation of one extraction well <sup>a</sup>	1,000 <sup>a</sup>	1,500 <sup>a</sup>	150-250 <sup>a</sup>	1	1,500
<b>Sutter Sub-basin</b>							
22D	Sutter Mutual Water Company	Installation of five additional monitoring wells, monitoring and data collection (feasibility study). One well in corner of district.	5,000	1,500 to 1,800	800-850	5	1,500
24A	Pelger Mutual Water Company	Installation of three extraction wells	1,000	500	127-250 <sup>a</sup>	3	500
30A	Meridian Farms	Installation of one extraction well	1,500	3,000	150-250 <sup>a</sup>	1	2,225
<b>American Sub-basin</b>							

**TABLE 2**

Summary of Supplied Project Information vs. Model Implementation  
*Groundwater Model Documentation*

<b>Project Index</b>	<b>Proponent</b>	<b>Groundwater Component Description</b>	<b>Maximum Project Supply (ac-ft)</b>	<b>Target Pumping Rate (gpm)</b>	<b>Screened Interval (ft bgs)</b>	<b>Number of Wells Simulated</b>	<b>Simulated Pumping Rate (gpm)</b>
7A	Natomas Central Mutual Water Company	Pump 13 existing wells, monitoring and analyzing results after one season	15,000	800 to 3,500	150-300 (11 wells) 400-500 (2 wells) based on well logs in the area	13	680-2,975
31A	Pleasant-Grove-Verona Water	Installation of one extraction well <sup>a</sup>	1,000 <sup>a</sup>	1,500 <sup>a</sup>	150-250 <sup>a</sup>	1	1,500
<b>Delta Sub-basin</b>							
21A	RD 2068	Develop a single production well to determine conjunctive use potential	2,000	1,000 to 2,000	300 to 500	1	3,000

Notes:

<sup>a</sup> Denotes an Assumed Project Component

manner to evaluate the effects of varying streambed and aquifer properties on drawdown and stream leakage.

Typical model output that can be used to support decision making for the overall program include:

- Groundwater contour maps at various times and at different depths in the aquifer
- Groundwater hydrographs that show the variation in groundwater levels over time at a particular location and depth in the aquifer
- The magnitude of the hydraulic gradient between the surface water and groundwater systems at various location across the model due to project pumping
- The spatial variability of stream impacts – i.e., the combined quantity of groundwater flow that would have discharge to a surface stream that was intercepted by project pumping along with any direct leakage from the river induced by the project (with the modeling techniques used here, these two components can not be individually estimated)

The results of the groundwater modeling analysis are in progress and will be presented under separate cover during the first quarter of 2004.

## 5.0 References Cited

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